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FABRICATION OF NANO-COMPOSITED Sn-doped ZnO/TiO_2 BASED DYE-SENSITIZED SOLAR CELLS

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ABSTRACT

Dye-sensitized solar cells (DSSCs) that belong to the third generation of solar cells are attractive due to cheap and ease of solar cell fabrication. Therefore, much research has been conducted to create an efficient solar cell. The following research illustrates for the first time development of aligned ZnO nanorod on Sn-doped ZnO films by using sonicated sol-gel immersion methods for dye-sensitized solar cells and the fabricated DSSCs show the improvement of photovoltaic properties and than from a novel photoanode of nano-composited aligned ZnO nanorod/TiO_2:Nb a significant improvement on photovoltaic properties was obtained. The Sn-doped ZnO films were used as a seed layer for nanorod growth, where the Sn-doped ZnO films at 2 at.% shows the best of electrical and optical properties. As a result, the aligned ZnO nanorod with relatively high aspect ratio was grown on ITO-coated glass at 2 at.% Sn-doped ZnO films using sonicated sol-gel immersion methods. The resulting of ZnO nanorod length and diameter were around 1.8μm and 120nm, respectively. Since the absorption of dye is dependent to aspect ratio or surface area ZnO nanorod and therefore the fabricated DSSCs shows improvement of energy conversion efficiency 0.599% as compared to the fabricated DSSCs using aligned ZnO nanorod on undoped ZnO film, ZnO nanorod on 1 at.% Sn-doped ZnO film and ZnO nanorod on 3 at.% Sn-doped ZnO film were 0.107%, 0.250%, and 0.206%, respectively. Besides that, the surface area of aligned ZnO nanorod was increased by varying the solution concentration parameter. It was found that by using 0.03M Zinc acetate solution the aspect ratio of ZnO nanorod was higher as compared to 0.05M. Therefore, the fabricated DSSCs using 0.03M ZnO nanorod shows the improvement of efficiency to 0.989 %. The aligned ZnO nanorod with better aspect ratio and larger surface area was efficiently for dye absorption and light harvesting that contributed to the improvement of DSSCs. Meanwhile, the presence of TiO_2 nanoparticles on top of ZnO nanorods might increase the internal surface area of photoanode that absorbed more dye molecules and resulting of increasing the photocurrent density 8.579 mA/cm^2 as well as energy conversion efficiency of 2.543%. Furthermore, the improvement of DSSCs for nano-composited aligned ZnO nanorod/ TiO_2:Nb was closely related to the improvement of electrical properties of TiO_2 nanoparticle from Nb-doped TiO_2 at 5 at.%. The Nb-doped TiO_2 at 5 at.% shows higher of electrical properties that contributes better of electron transport properties. A novel photoanode of nano-composited aligned ZnO nanorod/TiO_2 with Nb-doped TiO_2 at 5.% shows the significant improvement of photocurrent density and energy conversion efficiency of 18.156 mA/cm^2 and 5.376%, respectively. The enhancement of energy conversion efficiency of the nano-composited aligned ZnO Nanorod/TiO_2:Nb-5 at.% DSSCs can be due to the enhanced electron-injection efficiency caused by the positive shift in V_{fb} which help increase J_{sc} and reduce the charge recombination.

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